PHYSIOLOGY OF THE
ALIMENTARY CANAL

BRINTON

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CONTRIBUTIONS TO THE
PHYSIOLOGY OF THE ALIMENTARY CANAL.*

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PART I.

ON THE MOVEMENTS OF THE STOMACH.

I. *The anatomy of its muscular coat.*—There is little necessity here to dilate upon the well-known structure of the muscular stratum of this organ. That there is an external plane of longitudinal fibres, and an internal and transverse layer immediately beneath this, would be almost a sufficient description in the case of the simple-stomached mammals; and an alteration in the disposition of these layers relatively to the surface constitutes the chief difference at present made out in the majority of the fishes, the longitudinal layer being for the most part internal to the circular.

In man and some of the higher mammalia, descriptive anatomists have sought to distinguish a third layer, which, lying deeper than the two preceding, is directed from the right of the cardiac orifice over the large extremity of the stomach on its anterior and posterior surfaces, expanding as it descends, and returning into itself at the lower border of the viscus. But the situation of this layer—immediately beneath the ordinary circular fibres, and with difficulty, or not at all separable from them; together with its direction, transverse to the altered axis of the recurved and enlarged tube—seem to render it fairly inclusible in the category of transverse fibres; transverse, not to the apparent horizontal axis of the organ from the pylorus to the large extremity, but to that real axis of the tube which occupies its centre, and is terminated by its orifices.

It deserves, however, to be remembered, that a considerable difference exists in the amount of muscular tissue present in different parts of the stomach. In about the pyloric half of the organ, its muscular coat is perceptibly thicker, and the variation,

* This essay was written considerably more than a year ago.

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like some analogous to it which are met with in other animals, chiefly affects the transverse fibres.*

II. *The muscular actions of the stomach.*—Of the movements which are the immediate function of this contractile apparatus, little seems to be known. Haller† considered that there was an alternate peristaltic and anti-peristaltic action, which urged the food in corresponding directions, now forwards, now backwards; and thus resulted in a kind of churning of the alimentary matters. In support of this doctrine he adduces both observation and argument.

Under the first of these heads, his chief authority appears to be the experience of Wepfer, to the 87th and 251st pages of whose " Mémoire sur la Cigüe aquatique" he refers. One of these passages, however, is a general statement, and not a narrative of an occurrence; while the other offers no identity with the fact sought to be established. The observation of a " nunc sursum, nunc deorsum" movement, in the duodenum of a vivisected animal, from which the stomach had recently been cut, is scarcely any index of the probable ordinary movements of a healthy stomach *in situ*, far less a proof of what they really are. The argument made use of is that of necessity : a physical dilemma is attempted to be laid down. " Both orifices being shut, either the stomach must be quiescent, or the food must be sent by alternate movement backwards and forwards :" again, " if the course of contraction were simply forwards, the food would remain but a very short time in that organ." But the latter objection requiring that the pylorus should be open, will not, I think, demand a separate answer : the first can only be received with the great caution due to such methods of arriving at facts, and the error on which it is based will be pointed out in the course of this paper.

Somewhat similar to the opinion of Haller is the explanation given by Beaumont, of the movements impressed on the food. From these he deduces, that contraction occurs in alternately reversed directions; but it would also appear that he considered a kind of rotation of contraction to obtain, by the preponderant share of the greater and lesser curvatures in these alternate movements. But his views on this point are by no means clearly stated.

It is allowable, I think, to point out the simple structure and arrangement of these muscular strata, and to note their great similarity in every respect but quantity to those of the remaining portion of the alimentary canal. From these as data

* I have purposely forborne reference to the so called "transverse ring" which exists at the junction of the pyloric and cardiac portions. It is more properly included in the contractions of the stomach, for though remarkably distinct during these movements, yet anatomy fails to recognise a distinct band, or even any exaggeration of the ordinary circular fibres sufficient to merit a separate description.

† Vol. vi., p. 276.

we might almost argue, *à priori*, the improbability of their possessing any but analogous contractile powers; and the probability that the peristalsis of the simple tube of intestine, or of the simple tubular stomach, would scarcely be so greatly altered in quality by the mere pouching of one part of its surface, or the exaggeration of one of its sides, as to be changed from a simple forward contraction into a complex alternate or rotary movement; the immediate agents of that movement remaining so little affected as they are known to be in the human stomach and those of similar shape. But it will be preferable to any such speculations to examine into the facts themselves, so far as we may be able, and to inquire—What movements of the stomach are seen on laying open the abdomen of an animal, and what are their characters and varieties?"

In many of the lower animals the progressive peristalsis which obtains in other parts of the alimentary canal, is certainly retained as the stomachal movement; and in fishes generally it has been thus described by Profesor Owen.* " The muscular action of a fish's stomach consists of vermicular contractions, creeping slowly in continuous succession from the cardia to the pylorus, and impressing a twofold gyratory motion on the contents; so that, while some portions are proceeding to the pylorus, other portions are returning towards the cardia."

Some of the carnivorous mammalia, as the dog and cat, offer, in addition to other advantages, that of possessing a stomach which in shape closely resembles the human organ; and it is to these animals that the following observations directly apply. One source of error which might be thought unavoidable, is the stimulating effect which results from the admission of air to the peritoneal surface; but though in the case of the intestines the effect of this irritation is so great as seriously to interfere with the practical utility of observations, if not completely to mar their efficiency, yet its influence on the stomach is so slight that it might safely be dismissed from notice, while its tendency to cause irregular motions, makes it little of an objection to any uniform and constant movement which shall appear to have been observed.

On exposing the stomachs of these animals immediately after death, contractions may be seen, varying considerably both in quantity and quality, or they may be altogether absent.

1. *In the empty stomach.*—If we examine an animal from whom all food has been withheld for some hours previously, and whose stomach is void of ingesta, that viscus is seen completely at rest, offering no movement whatever. And even after the interval of a minute or two, when the intestines are exhibiting very active vermicular contractions, the stomach presents a marked contrast, and preserves its quiescent state.

2. *In the stomach which contains food,* two chief varieties of peristalsis are observable; and they occur in such uniform

* Hunterian Lectures, vol. ii., p. 236.

coincidence with the different stages of digestion, and contents of the cavity, as to be attributable to these as their causes.

a. In the early stage of digestion.—In the carnivorous animals above mentioned, and especially in the destitute specimens which are generally obtained for such experiments, it is not unusual to find that solid food has been swallowed hastily in large lumps, after little or no division, still less mastication. In such cases the stomach is found crammed with hard masses of flesh; and owing to this unyielding condition of its contents, very little contraction of its parietes is visible. This state is best obviated by chusing an aliment the consistence of which shall not interfere with the movements,—such as thick soup or other pultaceous food,—and administering it in quantity sufficient for moderate but not excessive, distension. If the animal be pithed about a quarter of an hour after, and immediately opened, the following movements will be seen going on:

The most noticeable is a transverse constriction, which sets out from the cardiac extremity, and travels slowly towards the pylorus. This is comparatively feeble until it reaches the locality of the " transverse band," which is situated at about the junction of the pyloric two-fifths, and cardiac three-fifths; here it suddenly becomes much more distinct, and from hence it continues rapidly forwards, as a well-marked circular depression, until it reaches the pylorus. Having arrived thither, an interval of relaxation succeeds, which is followed by the recurrence of a similar contraction: as nearly as can be judged, the average period of relaxation is about a minute, and the contraction itself occupies nearly the same time.

Cotemporaneous with this contraction is a certain amount of longitudinal shortening of the organ.

At this period the pyloric orifice is always shut, but the cardiac much less efficiently so. The difference between the two closures is well shown by the effect of pressure; for the same amount which easily forces the contents of the stomach into the œsophagus and mouth, expels none into the duodenum.

On laying open the organ, the ingesta are seen to be already somewhat altered: thus, where milk or soup have been given, flocculi of coagulated caseine or albumen are found floating in a dirty fluid.
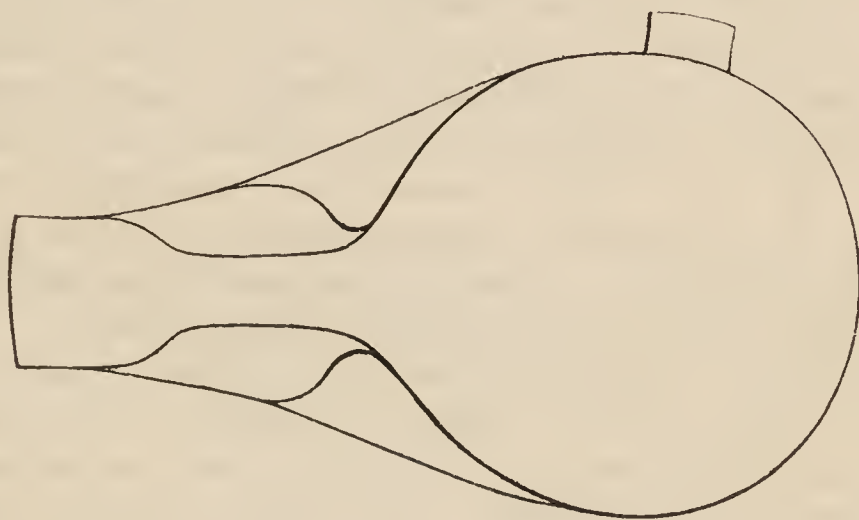
b. At a later period of the digestive act, the movement differs considerably from the preceding description, though it still offers the same general appearances.

Above the situation of the transverse band, the large cardiac extremity, dilated by its contents, is more quiescent than in the earlier stage. Movements, indeed, do occur, which are similar to those previously described, but they are so slight as scarcely to allow of their nature or direction being defined.

The chief visible commencement of contraction is by a constriction which has exactly the same place as the sudden increase

above mentioned (viz. almost midway between the orifices of the viscus), but is much deeper than it. After continuing a short time, it passes onwards to the pylorus as a circular concavity, which appears nearly to obliterate the tube in its course; and finally arriving at that valve, terminates by engaging the muscular ring which surrounds it. A slight relaxation follows closely on the heels of this peristalsis, and in a little while a more complete dilatation succeeds, but not exactly in the order in which the constriction had occurred, the central hour-glass contraction being the last which altogether disappears, as it is also the first to return. The accompanying diagram contrasts together by its three outlines—the commencement of contraction, its maximum, and that of the intervening dilatation.

Fig. 1.

While the contraction remains, the large size and fulness of the cardiac pouch, the well-marked circular depression, and the narrow pyloric tube, have often suggested to me the simile of a funnel, the expanded portion of which contained a quantity of fluid, which its tube (here a muscular one) was slowly draining off.

The contractions themselves are more rapid than in the earlier stage, but the intervals are rather longer—from one to three minutes; and a longitudinal shortening occurs, but it is even less prominent than before.

I have not been able to trace the movement clearly into the duodenum: indeed, the balance of evidence is somewhat in favour of an independency of movement in these two parts of the alimentary canal; since I have sometimes remarked that a contraction of the stomach began when a peristaltic movement already occupied the duodenum, at a distance of an inch or two from the pylorus, and that the latter both travelled at a much slower rate, and was repeated at much longer intervals, than the gastric constriction. But on this point it is necessary to speak with great hesitation, since there are many circumstances which tend to prevent an accurate observation of these intestinal movements, by simulating contractions, or distorting

those which already exist. Some of these will be more fully pointed out in a succeeding part of this paper; but I may here mention the action of the atmosphere, and the dragging which is the physical result of contraction in the immediate neighbourhood.

In general terms, the differences in these two stages might be briefly stated as follows:—Soon after ingestion, the peristaltic movements are more general, and more uniformly diffused, engaging the whole of the organ; but even now with a manifest preponderance in the pyloric half, and the pylorus is firmly shut; while towards the termination of digestion, the cardiac extremity experiences less movement, but the peristalsis of the pyloric portion becomes much more rapid and vehement.

The pylorus, doubtless, opens slightly at the end of each contraction. This may be due either to a relaxation of its muscular fibres, or to their tension being physically overcome, and the fluid forced through by the constriction behind; but since these two periods appear to coincide in point of time, and the slight relaxation of the ring which immediately precedes its greatest constriction is necessarily cotemporaneous with the advance of the general contraction, it may be supposed that each of these actions takes a share in the expulsion of the chyme.

And looking at both the preceding varieties, it may be fairly laid down, that, although these movements vary greatly in quantity, and somewhat in quality, they are yet all capable of being expressed as peristaltic contractions; or, in other words, they all present, as their most important constituent, a superficial transverse indentation moving gradually forwards. Though I have looked carefully, I have never been able to identify any irregular motions which would affect this rule, far less any approach to an inverted peristalsis.

I cannot avoid mentioning in this place, that both the appearances beheld in the contracting stomach, and a consideration of the arrangement of the longitudinal fibres here and elsewhere, unite in allotting to them the subordinate function of serving merely to preserve the tension which is necessary to the proper physical action of the deeper layer. And their comparative uniformity in amount and thickness, in many animals in whom the transverse stratum is greatly increased in both these respects, seems to corroborate this view of their import.

III. *The movements of the food.*—Turning from these observations, which have had sole reference to the movements visible on the exterior of the digesting stomach, we next come to inquire into the motions which they impress on the food as their result.

A twofold gyratory movement has been already quoted as present in the contents of the fish's stomach in the earlier part of the digestive process; and this simultaneous passage of different

portions in opposite directions, may be taken as the index of similar currents—one towards the cardia, one towards the pylorus.

The very careful and accurate experiments of Beaumont, will afford satisfactory evidence of something very similar to this. " The ordinary course and direction of the revolutions of the food are—first, after passing the œsophageal ring, from right to left, along the small arch; thence through the large curvature from left to right. The bolus as it enters the cardia turns to the left, passes the aperture, descends into the splenic extremity, and follows the great curvature towards the pyloric end. It then returns in the course of the smaller curvature, makes its appearance again at the aperture in its descent into the great curvature, to perform similar revolutions. These revolutions are completed in from one to three minutes. The bulb of the thermometer, which has been frequently introduced during chymification, invariably indicates the same movements. They are slower at first than after chymification has considerably advanced." *

Subsequently to this statement, he mentions that there is a perfect admixture of the whole ingesta; and that if the motions were simply revolutionary, the central portions would retain their situation, until the outer or chymified part had passed into the duodenum in successive parcels. The supplementary movement, by which rotation is converted into complete admixture, he considers to be a general trituration, which is partly the result of the same muscular contractions that cause the revolutions, partly produced by the respiratory muscles. But it is an obvious objection to any immediate alteration of the circular movement that the latter really obtains, and that it is of little use to grant the possibility of its conversion or modification into trituration by these means, when all his experiments, by substantiating the simple revolutionary character of the movement, prove that the change is *not* effected. But we shall presently endeavour to show that the circulation is of such a kind as necessarily implies mixture.

The opportunity so well used by Dr. Beaumont, is unique; and there are many difficulties which have hitherto been an obstacle to its artificial repetition in animals, so as to present any thing like trustworthy experience on the subject of these movements.

But of the accuracy of his experiments, few, I conceive, would entertain any doubt; and if the preceding observations have been as correct, we are brought to this point in the investigation:—that the movements of the healthy stomach during chymification are of a peristaltic character, and that the direc-

* Experimental Observations on the Gastric Juice. Combe's edition, page 101.

tion of this peristalsis is uniformly forward; but that the currents in the fluid or semi-fluid ingesta, are of two kinds, and in two opposite directions,—one being forwards to the pylorus, one backwards to the cardia. The apparent inconsistency of these statements, or the incompatibility of one movement with two currents, has now to be explained.

The most simple and obvious course, and one which, to some extent, will reflect light upon the data, as well as on the result, is to imitate the natural conditions and to observe and compare the effects.
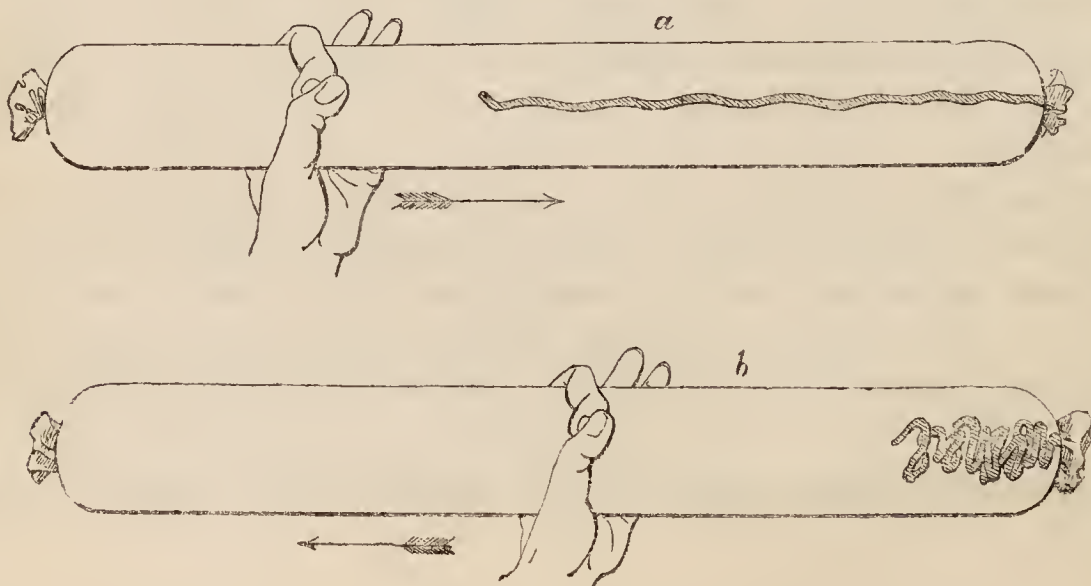
Thus, taking a long membranous tube, preferably of considerable size and width,—such as the prepared weasands sold to the sausage-makers,—and filling it with water, to moderate but not extreme distension, by tying up both extremities we tolerably approach to the condition of the simple stomach of some animals.

The opposed and semi-flexed forefinger and thumb will produce a transverse circular indentation, which, carried slowly forwards, will similarly come near to a peristaltic movement. By previously introducing any sufficiently visible and flexible object, of considerable length, little diameter, and a specific gravity somewhere about that of water, and by attaching this to the centre of one extremity, we shall obtain an index of the current developed in this part of the interior. Ordinary black tape fulfils these requirements.

And now, producing the transverse constriction in the manner just mentioned, and moving it rapidly and frequently from the one end towards the other, an elongation of the black string attached to the centre of that extremity to which the movement is constantly carried, indicates that a backward current of liquid in the axis of the tube is a coincident of the forward one which occupies its periphery: and like it is the direct result of the peristalsis. —Fig. 2, a.

A reversal of the direction of movement heaps up the previously-elongated tape against the extremity from which it was firmly extended.—Fig. 2, b.

Fig. 2.

Prior to any experiment, a consideration of the mechanism of such an organ leads to the same conclusions.

The simplest form to which we could reduce it would be that of an inflexible hollow cylinder, in which the transverse indentation might be represented by a circular septum, perforated at its centre, and capable of free movement on the interior surface of the tube which it accurately fits. Let such a septum be moved in either direction, and it at once exerts a pressure on the body of liquid contained in the end towards which its motion sets. The pressure being equal in all directions, a portion of the fluid escapes backwards through its aperture, and this retrograde course is, *pro tanto*, a current, and one which will be continually lengthened by the advance of the septum along the remainder of the tube. The successive movement of a series of such septa would result in the establishment of two currents in the liquid —a peripheric of advance, and a centric of return.

The membranous and distensible nature of the tube actually made use of complicates the result only thus far: that at the commencement of the contractions, some distension of the distal extremity occurs.
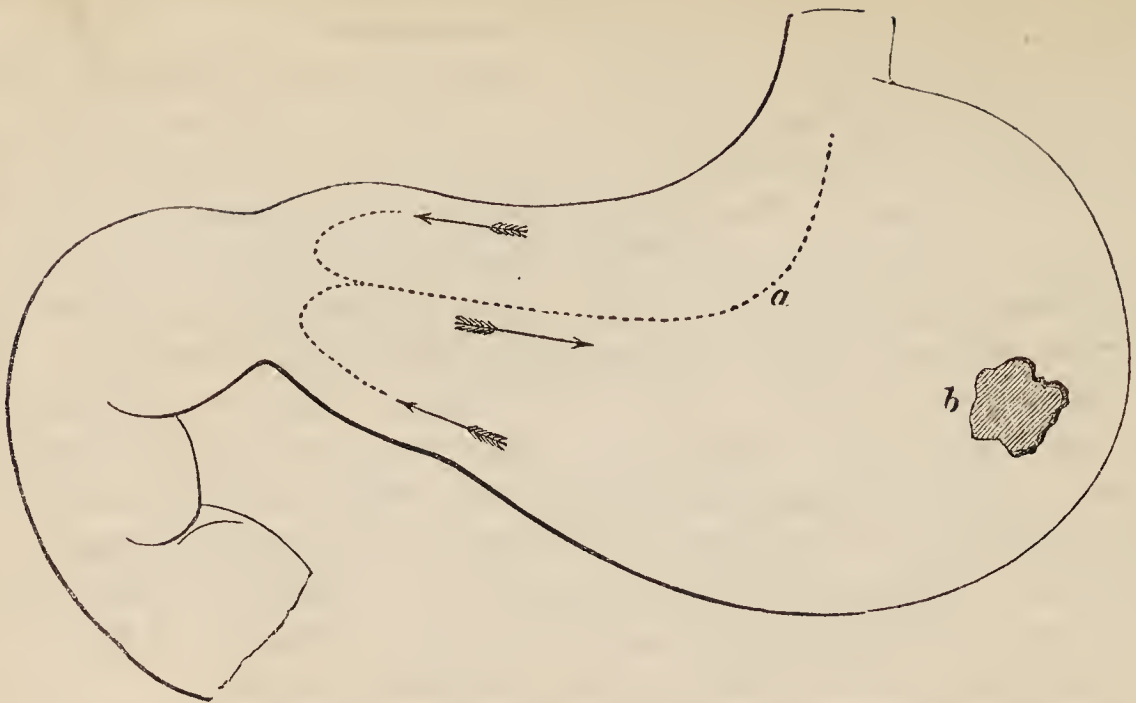
The inconsistencies before alluded to, might therefore probably receive the following explanation:

Transverse contractions, of uniform direction, occurring in a closed tube filled with a liquid, and falling short of obliterating its calibre, necessarily imply two currents—a superficial or peripheric, in the direction of those contractions, and an axial or centric, having precisely the reverse course.

The conditions here specified evidently exist in the case of simple tubular stomachs; nor does the modification of shape which is at present in the human and similar stomachs, affect their existence, since, so far as I have seen, the movements both in the cardiac pouch, and the more vigorously·contracted pyloric extremity, are transverse to the axis of the organ, as defined by its cavity and apertures.

And applying the same theory as before, it seems highly probable that we have at once a complete elucidation of the revolutions of the food, which Dr. Beaumont witnessed, and a corroboration of the general accuracy of his observations. The return of the alimentary bolus, was, to all appearance, along the lesser curvature; and when we recollect the situation of the opening into the viscus, from which his observations were made, it is evident that a movement along the real axis of the organ would be so near to the curved border, and comparatively so far from the point of view, that he could scarcely have avoided imputing to it the course which he has done.

FIG. 3.

a. Real axis of the tube.
b. Situation of the aperture in Dr. Beaumont's case.

The gradual mixture of the food is also explained: for, on the principle laid down, it is obvious that the activity of the pylorus, by occluding this part of the canal, has the direct effect, not only of retarding the onward passage of the contents, but also of impressing on them such a circulatory movement as must quickly result in their perfect admixture; since every part of the stomach is occupied by one or other of the currents, the mutual interference of which, at their borders, would gradually cause an uniform diffusion of matters moving with them; while the continuity of one current into the other at each extremity of the organ, ensures an equal contact of every portion of the contents with its active mucous surface, since the matters which occupy the axis during one moment, are destined to move along its periphery during the next.*

* Some of the currents seen in the Tubularian Polyp, by Mr. Lister, and described by him in the Philosophical Transactions for the year 1834, seem to approximate very closely to this general expression. Two currents were recognized in the tubular horny stem of the animal: they occupied different *halves* of its circumference, and proceeded in opposite directions. Two other currents engaged the communicating cavities of its contractile mouth and stomach. But these, although they also evinced a contrariety of direction, divided the tube in a very different manner,—that from the mouth to the stomach being situated in the periphery of the tube, while that from the stomach to the mouth occupied its axis. "The latter was suspended at the time of the close contraction of the stomach, and of the (general) discharge from the mouth into it."

Now, though transverse contractions of a marked character, and of duration equal to these currents, do not seem to have been observed in the soft contractile parietes of this part of the polyp, still it is impossible to avoid noticing their great similarity, both to those which probably obtain in the stomachs of higher animals, and to those seen in the rough model which I have suggested. And their contrast to those in the stem is perhaps significant of their different origin.

And it might be natural to regard the stronger and thicker condition of the terminal half of the stomach as having some useful relation to this circulation, not only by its more active influence, but also by its greater passive contractility, tending to prevent the dilatation to which this portion would otherwise be peculiarly liable, from the increase of action seen in this part of the organ.

In the present state of our knowledge, it would, I think, be too much to assume that these movements of its contents occur in the stomachs of all animals : indeed, in some of the carnivora (especially the fish-eaters) it is perhaps more probable that the ingestion of large immoveable masses of aliment is subsequently attended with so rapid and perfect a solution, that the process is scarcely necessary or possible ; but it is interesting to notice that even in these, as far as regards the organ itself, the conditions are certainly present : while we are also presented with a very simple means by which mastication of the food, where requisite, is, as it were, enormously exaggerated in its results,— since, on this view, division, by implying circulation, also implies a further sub-division ; and a coarse grinding in one stage of digestion is necessarily followed by a minute trituration in that which immediately succeeds it.

The anti-peristaltic action supposed to take a part in the healthy movements of the stomach is still more universally received as the immediate share which that organ takes in the production of vomiting ; but, as in the previous case, experiment negatives the doctrine : in an animal killed during repeated and copious vomitings, the movement was seen to be distinctly forwards, having a considerable general resemblance to that of the earlier stage of digestion ; but whether this movement be an invariable coincident of vomiting, a single observation would preclude one from judging.

In concluding this part of the subject, some peculiar actions may be alluded to, as possibly connected with this state of the food ; viz., the regurgitation of fluid which sometimes happens during the digestive process, and, with less likelihood, the easy kind of vomiting which is occasionally witnessed in very young children while feeding.

In the first of these cases the abdominal contractions and the closure of the glottis which occur in vomiting are absent, and the facility with which it happens seems to indicate that a full and contracting stomach, a patulous cardia, and possibly, the period of expiration, are the only conditions of its occurrence. Conformably to this, it is found that a slight pressure on the replete organ will produce a similar regurgitation in the recently dead animal, and, perhaps, the axial current, which probably obtains in the living subject, may facilitate the upward movement. It would be difficult to conjecture whether the opening of the cardiac aperture be the result of an increase of pressure

overcoming the resistance of the circular fibres which surround it, or whether these are merely relaxed: indeed, over-action of the longitudinal layer, where it expands in passing from the œsophagus to the stomach, would equally account for it.

PART II.

ON THE PHYSIOLOGY OF INTESTINAL OBSTRUCTIONS.

THE argument of the following part of this paper, and its connection with that which preceded it, may be thus stated:

The pylorus being shut, the peristaltic action of the muscles of the stomach resulted in a reflex current of the liquid ingesta. But the form of the intestinal tube, the structure and disposition of its muscular coats, and the probable action which they effect, so closely resemble the corresponding circumstances of the preceding organ, as to offer in these respects physical conditions which are essentially the same. Therefore, if disease or experiment add the only remaining requirements,—viz., those of occlusion and distension,—and thus complete the analogy of the intestine and stomach, the physical results obtained in the two cases will probably be referrible to the same principle; and the closeness with which they will approximate will be determined by the variations in these the common conditions,—variations the amount of which will be represented either by their number or degree, or by both these considerations jointly.

One of the most remarkable and constant symptoms of occlusion of the intestine is the occurrence of fæcal vomiting.

The explanation given by Galen, of the mechanism which effects this phenomenon, has remained up to the present time; and scarcely challenged during all this period, but repeatedly adopted and confirmed by succeeding authorities, it still rules so universally, that I am alike spared the necessity or possibility of quoting its advocates. What with its philosophic simplicity, the eminence of its supporters, and the completeness with which it accounts for the fact, perhaps few doctrines have a more impregnable appearance. And partly on these grounds the author trusts that, where the argument requires it, he may be allowed to anticipate, by a short statement, results which will be detailed more fully afterwards.

The theory may be thus briefly laid down. At a certain stage of an intestinal obstruction, the natural peristaltic action of the bowel above the occluded point is reversed, and, instead of proceeding towards the lower outlet, as heretofore, it passes in the contrary direction, impelling the contents in a similarly retrograde course, so as to return them to the stomach, whence they are vomited.

As far as can be collected, it would seem that by some the vomiting itself is supposed to constitute but a part of one continuous action; while others, who might be considered to separate the two stages (viz., the return of fæcal matters into the stomach, and their expulsion thence,) by considering vomiting to imply an antiperistalsis of the stomach, reduce them to much the same thing; the action in each being identical, its starting points only different.

On examining into the experimental foundations of this doctrine, I have been surprised to find the small number of facts which represent its basis, and the inefficiency of the few made use of.

Among the very numerous writings which affirm and illustrate the antiperistalsis, in those of Wepfer* and Schwartz† only have I been able to discover the results of experiment; and even in these the necessary parallelism of both the preliminary conditions and the produced effects is completely wanting. None of these experiments included obstruction of the cavity of the tube, although it is notorious that with this condition alone the symptom sought to be explained is connected; and in none was fæcal vomiting present. So also in none was the antiperistaltic movement substantiated; for that described is in every instance an irregular vacillating motion. Wepfer, indeed, expressly defines it as a "nunc sursum, nunc deorsum" movement: and Brünner, whom he quotes, mentions a similar action, in the same words, as obtaining in the rectum of a living animal, while the fæces were being propelled in the normal direction. And, on the whole, I have found it impossible to come to any other conclusion than this,—that an anti-peristaltic movement has never yet been seen in any part of the alimentary canal. But although the facts observed by these authors seem not to warrant the inferences they have drawn from them, yet the existence of such irregular actions is undeniable; and in this view they demand some attention.‡

When the abdomen of a healthy animal is laid open imme-

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* Op. cit.

† Haller's Disputationes Anatomicæ.

‡ Antiquarian research might, perhaps, somewhat modify this statement, but I suspect very slightly only, since numerous observations seeming to bear on the subject, and quoted by these older authors, on close inspection are found quite wanting in relation to that which they are brought forward to confirm. One author must be especially mentioned here, as having combated the anti-peristaltic theory: this was Haguenot, whose thesis is given in Vol. I. of Haller's "Disputationes Anatomicæ," and in which the author of this paper found some of the objections raised by him had been anticipated. But Haguenot adopted the singular view of attributing all the movements in the intestines almost entirely to the diaphragm and abdominal muscles; and considered that, on the occlusion of the tube, a tendency of liquid towards the least resistance, expressed the cause and mode of its return to the stomach by the same forces.

diately after death, the intestines are seen lying perfectly still; but in a very short time, those parts of them which are exposed to the air, experience vigorous contractile movements. In many instances these are irregular and indefinable; but in other cases they take on appearances of a forward or backward course, or sometimes of each of these directions alternately.

In those instances where a direction of transverse contraction is best marked, the circular depression is preceded by a dilatation which stretches the intestine to the full length of its mesentery, so that it rises, as it were, at the extremity of this its tether; and immediately to this succeeds the circular indentation, travelling slowly onwards.

A forward course of these constrictions is certainly by far more frequent than the reverse, but both occasionally obtain, while it is perhaps more usual to find them without any direction capable of identification; and in this respect they are much more truly named " vermicular," than " peristaltic," movements.

After a few minutes, the contraction of the intestines (which ordinarily contain but little fluid) gives them a nodulated or almost moniliform shape. Gradually the movement wholly ceases, but the contracted condition endures for a considerable time.

On raising these parts of the canal, and disclosing other portions hitherto concealed, these also pass from a condition of comparative rest, into one of like activity to that previously described; and, after experiencing movements of an identical character during about an equal time, they finally attain the same quiescent and permanently contracted state. The behaviour of the stomach under similar circumstances was noticed in a former part of this paper. A comparison of the small intestines and stomach, under these circumstances, led Glisson to imagine that the movements of the latter organ in health were slow, insensible, and in no degree approaching to those of the intestines. But, in spite of these appearances, the reverse would be a far more correct statement.

Now the tranquillity of these parts previously to the admission of air,—the irregular and diffuse nature of the contractions themselves, which correspond to the widely-spread application of the stimulus,—the final result on the intestine,—and the effect of uncovering fresh portions,—together offer the strongest probability that the movements witnessed are chiefly due to the irritation consequent on the admission of air. Perhaps we might almost term it a sort of precipitate rigor mortis, resulting from an amount of exposure to the cold atmosphere, which hours only can produce in the case of the muscular tissue of other parts of the body.

But whether this comparison be true or not, it is sufficiently evident that there is nothing here which can be called an

inverted peristalsis, and little even of analogical aid to assist us in conjecturing the definite movements which undoubtedly occur in these parts during life.

In the case of the artificially occluded bowel, and where the vomiting of fæcal matter has been a prominent symptom during life, an examination immediately after death gives very similar results; but some differences do obtain, and these appear to be chiefly connected with the degree in which distension of the intestine has taken place.

If the bowel be enormously dilated by its contents, it will, for the most part, be found that in the parts so distended none of this vermicular action obtains. If fluid be present in less excessive quantity, the movements are both more evident and more distinctly and uniformly peristaltic than in the healthy intestine. This effect appears to depend on two causes : on the contents offering an object on which constriction can be made manifest; and also, I believe, on a direct increase in the energy of the movements themselves; but their apparent direction is subject to the same uncertainties as in the healthy intestine, though in a less degree.

Thus, the observation of an inverted movement fails us, even in the condition the symptoms of which it was supposed to explain; and, on the whole, there are still fewer appearances of a backward movement in the strangulated than in the healthy tube : while all the positive evidence of these observations is in favour of a similarity of contraction in the obstructed and un-obstructed states,—the few differences offered being directly or indirectly assignable to their physical condition.*

We next proceed to adduce some arguments against the consistency and probability of the antiperistaltic theory.

1. The antiperistalsis is supposed to occur from the over-irritation at the stricture inverting the natural action of the bowel. The following quotation,† though originally written of the stomach, represents this view with sufficient accuracy :—

" All substances which, when their action is moderate, promote the peristaltic motions of the irritated parts, by a more violent operation cause those motions to become reversed."

It is a serious objection to any theory which would constitute irritation the first link in the chain of cause and effect, that,

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* The vivisection of healthy and obstructed animals, and the comparison of the intestinal movements in the two states, will probably suggest itself to many as an *experimentum crucis*. But the appearances observed in tying the intestine of several animals were sufficient to show that no hope of such a satisfactory result could be entertained, since in these cases I was not able to identify a definite peristalsis before deligation. It would thus appear that either the movements of the bowel are considerably affected by the operation and exposure, or that, during health and in their normal situation, their movements are of much less visible dimensions than the gastric contractions, to which they are probably analogous.

† Müller's Physiology, translated by Dr. Baly.

however we may interpret the term, we cannot name any morbid state or affection of the bowels in which irritation is not present; while an occlusion of their cavity in some part of its course is the only condition in which fæcal vomiting is present; that, in fact, the alleged cause is almost universal in the pathology of the organ, while the alleged effect is rare and exceptional. Nor can we show, or even plausibly speculate upon, any differences in the degree or kind of irritation in the different diseases of the bowel, which should cut off the occurrence of the result in so extensive a number, or rather so vast a majority.

On the other hand, since we find a physical fact—occlusion— to be the necessary condition of a peculiarly physical pheno- menon—fæcal vomiting—there are considerable grounds for suspecting some immediate physical causation in this circum- stance, the nature and frequency of which so closely coincide with those of the effect.

2. Of nearly equal value is the objection drawn from the condition of the replete intestine. Where, as frequently happens in these cases, the occurrence of the effect (fæcal vomiting) many hours or even days before death, and its continuance up to that event, ought to imply a similar duration of the antiperistalsis which is the cause, a post-mortem inspection offers appearances utterly irreconcileable with this. From the analogy of other contractile tubes, we might fairly expect that a sufficient quantity of contents would by this time have been propelled in the direc- tion of motion, to render the calibre and distension of the intes- tine at least uniform throughout, if not greater at the upper part of the duodenum, towards which the movement had set. But the contrary is invariably the case : that which should have been the starting point of contraction evinces the least signs of its presence, and is by far the most distended part of the bowel; and from this point upwards, the intestine tapering away like a cone, soon regains its normal diameter, and generally dwindles to comparative or even absolute emptiness before arriving at the pylorus.

In favour of the simpler view, we may notice the great general resemblance of this state to that which is seen in all cases where tubes, conveying fluid contents, are strangulated in some part of their course. After such a condition has obtained for some time, the appearances are uniformly those of dilatation immediately behind the obstructed point. And, though we might attempt the distinction, that the contents are evidently returned in one case, and only accumulate in the others, yet it must be remem- bered that this is true so far as regards our detection of the fact, but is insufficient to establish its negative. It is, in strictness, only another mode of stating our ability to recognize, by certain qualities, that such and such matters have reached a point in the intestine nearer to the obstruction than that in which they are found; and our inability to predicate the like where no such

differences obtain (or have been seen) at different parts of a tube; our inability, *e. g.* to say whether urine found in the pelvis of the kidney has ever occupied the occluded ureter; or bile found in the liver, its obliterated duct; or blood found in the heart, its strangulated vessel. But it is probable that within the limits of this general analogy, considerable deviations exist. These will be subsequently pointed out, and their explanation attempted.

3. In one particular kind of obstruction, viz. intus-susception —a peculiar condition is found after death. A superior portion of the intestine has passed into an inferior, and its occupation of the latter part, added by distension, congestion, or inflammation, has resulted in occlusion, with its ordinary symptoms and fatal effect.

It has occurred to me, that by the reduplication itself, Nature appears to inform us, not only of the cause of intus-susception, but even of the very steps of its development. In looking at such a specimen, we seem to behold a case in which the agents of disease are, as it were, taken in the very act. The longitudinal fibres remaining quiescent, the intestine has been surprised by a transverse constriction, the rapid passage of which forwards has hurried the contracting portion into the flaccid and dilated part immediately anterior to itself.

With a circular wire, and the finger of a glove, we may tolerably imitate both the conditions and the result.

The circumstances of these invaginations corroborate the evidence already afforded by their uniformity of direction and anatomical appearances. It has long been known, that whatever tends to irregular action of the intestines, favours the production of intus-susceptions, and that the general agitation which accompanies the mortal agony, often leaves them as its relics in the dead body; their recognition by the eye of the anatomist being the first and only sign of their existence.

Now, though a continuance of the transverse peristalsis would obviously be useless as a means of disengagement, nay, more, would only aggravate the evil, by tending still further to introduce the upper contained portion; and, though we can readily imagine that the very gradual accumulation of fluid from above, would but develope and dilate an abnormal pouch or valve, to the stricter obliteration of the cavity of the impacted portion which it surrounds; and, though in all probability it would require the most vigorous contractions of the previously slumbering longitudinal fibres, both above and below the intus-susception, in order that these unaided should restore the natural condition; yet it does seem evident, both from the nature of the theory, and the rude model I have suggested, that an antiperistalsis would so effectually, and of necessity, remove the condition, that the theory of such a reversal is well nigh incompatible with the fact of the invagination.

The effect that the longitudinal fibres would have in assisting

reduction, is sufficiently obvious ; but even supposing the anti-peristalsis literally reduced to a transverse constriction, the result would be little affected : for the advance of such a constriction seems to imply a dragging behind it.

An inverted movement of this kind would at once diminish the diameter of the impacted portion, and, as it proceeded up-wards, draw the so narrowed tube out of the part containing it. It would thus imitate, under the happiest circumstances, the conduct of a surgeon who reduces a paraphimosis ; while with one hand he compresses the strangulated glans, and reduces its size thereby, with the other he simultaneously pushes it through the strangulating ring of prepuce, or, what is virtually the same thing, draws this over that.

The operator knows that each of these actions is essential to the result ; and that first mentioned—viz. compression—would probably be even more necessary in the case of the intestine, where the texture of the muscle, and its independence of voli-tion, offer much earlier limits to the energy of the tractile share of restriction than the powerful mechanical force which the operator can exert at will.   And, so far as I can see, an anti-peristaltic movement is almost the only way in which both these could obtain at the same time.

4. The nature of the movement affords some ground of objec-tion.   The supposed antiperistalsis is a continuous motion, the vomiting only an interrupted phenomenon ; an inconsistency, if they are considered as one and the same action. And, therefore, a theory which showed an essential independency of the two acts—of this backward passage of fæces into the stomach, and their expulsion from it—would be so far preferable.   But since many who receive the ordinary view evidently distinguish these as two stages, though not as two actions, little stress can be laid on this objection derived from their observed independent nature : and hence its consideration is deferred.

5. But although an extension of this action to the stomach might be considered as only indirectly, or not at all involved in the antiperistaltic view, it is incontestable that the supposed action ought to extend in both directions far beyond the irritated or occluded point : while, in striking opposition to this, it is found in numerous instances that the ordinary peristalsis of the tube has gone on in the part below the strangulation ; satisfac-tory evidence both of the existence and power of this movement having been afforded by the expulsion of the usual solid contents of the bowel.   Defæcation after the obstruction and vomiting have persisted many days, is by no means an uncommon occur-rence.   In animals where this condition has been artificially induced, I have almost always found an empty contracted state of intestine immediately below the stricture.   And, finally, in one experiment, where the deligated intestine of a cat was evidently filled with solid fæces at the time of the operation, an examina-

tion after death showed that this part had been subsequently emptied.

And even were it imagined that by some inexplicable peculiarity, the reversed movement only engaged those parts of the canal which lay within its course, and superior to its starting point, yet it must be borne in mind that this emptying of the tube immediately below, requires that the peristalsis shall have commenced from the very seat of the stricture; and thus, from one and the same point, to which has been applied one and the same stimulus, two opposite movements have set forth; the one upwards towards the stomach—the other downwards towards the rectum.*

6. The varieties in the date of occurrence of the symptom form the last objection I shall urge.

We might, indeed, prelude it with a remark on the ordinary time of its appearance, which somewhat disfavours the idea that the return of fæcal matters is due to so immediate and complete an agency as antiperistalsis; and in support of such an inference, we might adduce the well-known fact, that under irritation the whole length of the human alimentary canal may be traversed in six, four, or even two hours; while in cases in which we can assign the precise time of strangulation, at least twenty-four hours are generally occupied in the passage of only a fraction of its length. But this argument might be considered hardly a fair one, since many would reply that the theory did not suppose a reversal of movement to ensue instantaneously on occlusion.

A more valid objection may be drawn from the comparative date of its accession in different cases. The time at which the symptom first appears, might indeed be expected to vary in direct relation with the distance of the stricture from the stomach; but observation shows that the true causes of such variations would only be partially stated. The rapidity of its occurrence in reality depends on the quickness with which the tube above the occlusion becomes distended. And a further analysis of this distension shows it to be compounded of two things—length of cavity, and quantity of contents. And if these opposite elements be arranged as a fraction, the whole variation might be included in this simple formula—

$$\text{quickness of vomiting} \propto \frac{\text{contents}^\dagger}{\text{height}}$$

—where, if the contents be constant, the rapidity with which fæcal vomiting comes on will be inversely as the height of tube

* It might be answered, that the emptying of this part occurred before the establishment of the retrograde movement, and that the subsequent defæcation only implied the action of the termination of the bowel, and not of the part near the stricture. The improbability of this is manifest, but absolute disproof is difficult.

† Or, vice versâ, the time preceding the occurrence $\propto \frac{\text{height}}{\text{contents}}$ i.e., varies directly as the numerator, inversely as the denominator of the fraction.

to be filled ; or, if the latter element be constant, will be directly as the quantity of fluid which secretion or ingestion together afford.   Distension is thus not only essential to the occurrence, but is that which chiefly regulates its access.   Now, distension is no more a condition necessary to antiperistalsis than to peristalsis, while, as will be hereafter shown, it is essential to the theory which the author seeks to establish.

I have next briefly to detail the results of experiments in which the intestinal tube was artificially occluded by the application of a ligature ; some of these have been already adduced, where their connection with preceding parts of the argument has rendered such a course desirable; and it only remains to examine more minutely into the symptoms and post-mortem appearances, with a view to elicit any additional circumstances from which we may derive assistance in deducing the theory of this action, and assigning its relations to others which resemble it.

The animals subjected to the operation were dogs and cats. The latter were previously rendered unconscious by the administration of ether; but with the former nothing but a very noisy struggling intoxication was produced in the one or two cases in which that drug was used.

A thick tape constituted the means of deligation, and this was generally tied so as to obliterate from half an inch to an inch of the canal, in order to avoid the restorative process described several years ago by Mr. Travers.   Despite this precaution, in one instance where the ligature was a little narrower than usual, a sudden remission of the symptoms led to a suspicion that this process had occurred, and the steady improvement which followed had almost attained apparent health when the dog was killed ; on the fifth day after the operation, and the third from the cessation of the vomiting.   The intestine was found to be completely united in its whole circumference.   Internally, the mucous membrane offered two raised lips separated by an interval ; and in contact with this circular fissure ran the ligature, which so far preserved its shape as to occupy, without occluding, the cavity of the bowel.   Externally, a thick coating of soft coagulable lymph covered the seat of the original stricture.   The ligature itself was of a sufficient breadth and thickness to make it very unlikely that any of the coats of the intestine had been divided at the time of the injury, as was supposed to have happened in the cases detailed by Mr. Travers ; but with this probable exception, nothing can be added to that gentleman's description.

In every other instance the intestinal canal was greatly dilated immediately above the strictured part, but to a variable extent : thus, where fæcal vomiting had occurred, the distension was generally excessive.   From this point the tube gradually narrowed as it was traced up to the stomach, rarely exceeding its

natural diameter in the upper extremity of the duodenum. The length of the dilatation exhibited a close relation to its greatest width.

In one case, the inflamed and injured portion was soldered by lymph to a neighbouring loop of intestine, and in this manner had effected a singular secondary constriction, and it was only above this latter stricture that any marked dilatation was present.

It is singular to remark how little will sometimes suffice to effect the physical obstruction of a bowel, as in this instance. A similar one was brought under my notice in the human subject. The division of the stricture of a strangulated hernia had been followed by no remission of the vomiting or general symptoms. An artificial anus then formed at the wound, to the immediate relief of the patient : but on her dying some days after, of the consequent exhaustion, it was found that at the seat of the stricture the liberated tube was still almost obliterated. The introduction of a finger easily overcame this contraction, although for twenty-four hours after the operation the whole powers of the intestine (such as they were,) must have striven in vain against it. Similar cases are probably known to many surgeons.

The degree in which the stomach was distended offered considerable variety; where excessive, it was partially due to the ingestion of water. The pylorus was generally open, always easily permeable.

Below the occlusion, an inch or two of empty contracted intestine was almost universally present.

The fluid found within the tube varied both in *quality* and *quantity*.

In some, in whom its amount was very great, an uniform green fæcal fluid occupied the whole of the intestine and stomach. In others, there was a decided difference in the consistency of the contents, which were often of a hardish pultaceous character in the immediate vicinity of the stricture, but more fluid in the neighbourhood of the pylorus and in the stomach.

Gradations of amount were also well marked. They ranged from enormous distension and dilatation of the greater part of the intestine between the stomach and the strangulation, and increasing with proximity to the latter point, to the occupation of the nine or twelve inches of intestine nearest the occlusion, leaving the remainder nearly or quite empty.

The former condition was always associated with stercoraceous vomiting; but the latter was limited to those few cases where this symptom had not set in at the ordinary date, and where the animal had either been killed, or (as in one instance) had died of the disorder.

Occurrence of fæcal vomiting.—Varieties in the *date of accession of the vomiting* appeared to depend on several causes.

In some instances, the mere irritation of the operation seemed

to produce it: but though coming on immediately, it was only after an interval of eighteen or twenty hours that it acquired a fæcal character. Somewhat was also apparently due to the kind of animal selected. Generally speaking, the dog vomited much more speedily and regularly than the cat: indeed, in one or two instances, the latter animal did not reject any matters up to the time of its death.

But this difference may probably be ascribed, not so much to a peculiarity of the constitution of the dog, as to the fact, that under these circumstances he drinks eagerly and frequently, and by thus distending the stomach in all likelihood favours the occurrence of sickness, or perhaps aids the intestinal distension. In three cats no vomiting whatever occurred. One of these died on the third day, and on inspection, its stomach was found tolerably distended with a distinctly fæcal fluid. Another was killed on the fourth day, and here the stomach was found empty, having an interval of empty duodenum between it and the fæcal contents above the strangulation. The third lived nearly twelve days, with a tolerable appetite and appearance, and at the end of this time was killed: here also the intestinal repletion above the stricture was moderate, but it extended nearly or quite to the stomach, and a small quantity of fæcal matter occupied the cavity of this organ.

Thus not only do these cases present us with what seems to be a rare exception in the human subject, the occurrence of complete intestinal obstruction, and its continuance or fatality, without fæcal vomiting, but two of them further establish that the return of these matters to the stomach does not necessarily imply their ejection thence.*

The date of vomiting appears to be likewise affected by the distance between the ligature and the pylorus; or by the length of intestine which the returning fluid has to traverse. But the comparative shortness of the alimentary canal in these animals renders variations in this respect so limited, and so immeasurably overpowered by differences in the quantity of fluid, that this statement can only be made with caution, especially since it seems probable that the hardened fæces present in their small intestine at the time of ligature may oppose so considerable a barrier, as to render the real distance at first somewhat less than the apparent one, and thus offer an additional element of confusion.

In the human subject, the greater length of the small intestine, and the more fluid condition of its contents, render the date of occurrence a valuable means of diagnosticating the probable

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* This analysis of the action, and its separation into two independent stages, is completed by a singular case detailed in the Transactions of the Pathological Society of London, vol. 1, p. 62. Here, owing to an ulcerative communication between the stomach and colon, there was fæcal vomiting without any obstruction.

situation of the stricture, and liable to little source of error save one,—that introduced by the possibility of great variations in the quantity of secretions or ingesta.

The *amount of fluid* much more evidently affected the accession of this symptom, chiefly because a certain amount of distension seemed necessary to the introduction of fæcal matters into the stomach. But it is possible that it may also act in another manner, and favour vomiting by presenting a "*point d'appui*" against which the respiratory muscles may compress the stomach. The peculiarly easy character of this species of vomiting may perhaps be partially explained by the abdominal distension which it supposes.

The *rapidity with which death followed* the operation varied remarkably with the degree of distension. It rarely occurred under forty-eight hours : the maximum time noticed was twelve days, but in this instance the aspect of the animal when killed, and the moderate quantity of fluid contained in the bowel, affords no room to doubt that it might have lived some days longer. In one or two instances, the fatal result appeared accelerated by the accidental complication of sloughing and effusion into the peritoneal cavity, followed by extensive peritonitis.

Theory of fæcal vomiting.—The following theory is, I think, fairly deducible from the preceding facts, and presents at once the most natural and consistent explanation of the phenomena in general.

When any part of the intestinal canal has its cavity obliterated by an immoveable mechanical obstacle, a movement of the ordinary character propels its contents forwards, until they are arrested at the obstructed point. A continuance to the process distends this part of the canal, and gradually the dilatation extends upwards. The analogy of the intestine to the stomach, and the vague results of atmospheric stimulus, lead us to consider its normal movement as almost certainly of a peristaltic character; and if the contents of the dilated part are fluid, this peristalsis tends to develope *an axial reversed* current, which returns matters from the immediate neighbourhood of the strangulation to some higher point in the canal; and thus, if the distension have reached the upper extremity of the duodenum, a portion of fluid possessing the properties of the intestinal contents near the obstructed part occupies the immediate neighbourhood of the stomach ; and a continuance of the movement introduces this fluid through the unresisting pylorus,* into the cavity of that organ. Having attained the interior of the

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* The little resistance offered by the pylorus to the passage of duodenal contents has been long known ; *e. g.,* a little bile generally exists in the non-digesting stomach.

stomach, either by distension or irritation, or both combined, it provokes vomiting, and is expelled from the mouth.

But it is probable that this brief statement of the theory will require modification, to render it applicable to some of the cases witnessed. For though great distension of the intestine was seen to be associated with a complete uniformity of fluid, which perhaps almost presupposes a circulation like that noticed in the stomach, yet, in many cases, the remarkable difference in the consistence of the contents at the obstructed and duodenal ends of the dilatation, would seem to lead us to the inference, that it is only by a slow process that the more solid fæces are broken down. These latter instances, however, equally exhibit a stercoraceous character of the matters vomited, and of the whole contents above the strangulation; and while they prove that uniformity of fluid is by no means necessary to the symptom, or even to the fatal result, they also appear to indicate that a sufficient duration of the action would always convert the partial mixture into a complete one. But it may be questioned how far the peripheral and central currents actually obtain, and whether we may not refer this incomplete mixture to the agitations which the contracting tube impresses on its contents, without supposing any precise direction or number of these movements.

But though in none of these cases has the fæcal obstruction appeared sufficiently hard and complete to form a secondary obstacle, from which the backward current might start (as doubtless happens in those cases of disease where it constitutes the primary cause of obstruction), yet I think it preferable to bear in mind that this would be the chief tendency of an increased consistence of the contents—viz., to increase the distance from the stricture at which the more fluid portions would experience their reflection upwards, and thus to interfere with the perfection of mixture. And, on the whole, the results are so similar in kind, and glide into each other by such insensible degrees, that they are fairly susceptible of being grouped together: the more so, that the fact of a majority of these obstructions in the human subject, being situated in the small intestine, removes a like per centage of cases from the category of imperfect mixture.

And we are no longer at any loss to comprehend how an occlusion of the large intestine returns its contents into the small intestine, and causes fæcal vomiting; since the preliminary dilatation* would produce a patulous state of the ilio-cæcal valve in all respects identical with that seen in the inflated and

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* I need scarcely add, that dilatation by the pressure of a fluid implies the exertion of an equal force in all directions and upon all points of the interior— including both surfaces of the valve; and that subsequently a tension of this structure is added, which increases its patulous state.

dried preparation of this part, and the peristalsis would then bring back the natural contents of the tube, and in a greater or less quantity according to the degree in which their previous consistence, the movement itself, and the fluid subsequently poured out, had together resulted in an uniform liquid state.

The degree in which peristalsis is affected by obstruction can scarcely be deduced from these observations : but taken in conjunction with the well-known phenomena in man, they indicate that it is much increased during a considerable time, and while only moderate distension is present ; towards the fatal termination, and with excessive dilatation, contractile energy seems somewhat diminished, perhaps we may say exhausted.

The nature of the distending fluid is also little elucidated. One or two microscopic examinations, however, revealed immense multitudes of cytoblasts, and few or none of the ordinary columnar cells; and hence it would appear that the natural secretions are augmented by the products of an over-excited nutrition, which may be compared to inflammation.*   Whether this was solely due to the mechanical irritation is doubtful. The share which the ingesta take in increasing the quantity of fluid has been already noticed ; how far they affect its quality is less important.

Finally, in *comparing the occluded intestine with the stomach,* it is submitted that the following differences of conditions consistently explain those of the results :—

The former is occupied by fluid in small quantity, and the gradual accumulation of its contents corresponds with the necessary period which precedes the accession of fæcal vomiting. Its parietes possess far less muscular strength than those of the pyloric extremity of the stomach ; and thence the dilatation above the stricture, instead of the unaltered shape of the stomach. The time required by the previous difference is yet further increased by this.

The length of the intestine implies an additional period of time before the repletion of the whole can assimilate its condition to that of the naturally filled stomach.

The occasional existence of solid contents in the small intestine of the animals operated on, and in the large intestine of the human subject, offers an obstacle to the production or perfection of the currents, which the ordinary fluid state of the food in human stomachs does not present.

In *comparing* the occluded intestine with *other strangulated tubes,* a consideration of their mechanism also appears to account for their various appearances.

Thus, in an obstructed artery, the distending force is from

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* Great differences exist between these appearances and those of the products of idiopathic inflammation in the same tube ; but they are excluded as irrelevant to the present subject.

behind, and uniform fluid contents fill its cavity; and hence, if its coats be everywhere of equal strength, the partial preponderance of the force over their resistance will determine an equal dilatation of all parts of the tube.

In an obstructed *bile-duct* we approach more nearly to some of the intestinal conditions. A gradual process of filling here occurs; but the parietes, though little muscular, are tougher and more resisting than those of the intestine. And hence, though the dilatation in its earliest stages exhibits some increase immediately behind the stricture, yet, in a case of long standing, the whole tube and its ramifications are pretty equally distended.

In the occluded *intestine* we are presented with a highly muscular and yet extremely dilatable tube; and hence the swelling behind the obstruction is at first enormous, since the former circumstance carries matters rapidly forwards to that point, while the latter allows of great accumulation before the parts above are implicated. The difference of calibre gradually diminishes as the upper portions successively fill, and perhaps would ultimately disappear, but that death intervenes long before such an event can happen.

The immediate result of such a theory on practical medicine, even when taken at its utmost valuation, may not be large; but if it be true, what has hitherto been thought a symptom will assume the importance of a sign; while the locality of the obstruction will be somewhat indicated by the date of its occurrence. As to the *treatment* of such cases, the theory assigns the causes which accelerate death, and the circumstances with which the greatest delay of that event is associated. It thus establishes, that from the moment of perfect obstruction purgatives are poisons; it indicates the necessity of rigid abstinence from all but the most necessary food, and especially from fluids; and points out opium as the best means of alleviating pain, preventing secretion, and prolonging the doomed life.

But all this is only corroborative of what has been known and done before. The symptom has long been considered pathognomonic, and the ill effects of purgatives are fully recognised. And I am by no means certain that the presumption of situation which the date of the symptom affords, has altogether escaped observation.

The experiments adduced might have been much extended; but there are two facts which may constitute a considerable apology for what would otherwise be a reprehensible parsimony of trouble. The first is, that while, on the one hand, there was some danger of generalizing from insufficient data; on the other hand, every such experiment over and above what was necessary would have been so much cruelty. The next is, that the verification and extension of all these details is unfortunately but

too easy: the collected hospital cases of the next few months would afford ample grounds on which to reject or receive this theory.

But the author ventures to hope that the principle which he has sought to establish will be found substantially correct. And with respect to the doctrine of an antiperistalsis, he knows no better general expression to which this theory could be reduced than the imperishable words of Bacon, with which he begs leave to conclude this paper. " Sunt denique idola quæ immigrarunt in animos hominum, ex perversis legibus demonstrationum, quæ idola theatri nominamus. Neque de philosophiis universalibus tantum hoc intelligimus, sed etiam de principiis et axiomatibus compluribus scientiarum ; quæ ex traditione, et fide, et neglectu, invaluerunt."

22, *Bloomsbury-street.*